

Micro VCM Test

Composite Mirror Qualification

Goddard Space Flight Center

MICRO VCM TEST REQUEST AND DATA SHEET PER ASTM E-595-90

(Requestor please read, then furnish all information above asterisks.)

Requested by: Neil Walter / Peter Chen Phone: 6508/5143 Date: 10/13/00
 Material identification (product name, number, description, classification, etc.)

M55J GRAPHITE BLACK

Manufacturer of Material (Name, City and State Address): BRYIO
 Material application (general usage, i.e. adhesive, coating, potting, etc.): LAMINATE
 J. O. Number: _____ Request Infra-Red Spectra? ☐ YES ☒ NO
 Originator/Source/Code (other than Code 300): 331

Indicate processing required by GSFC Materials personnel. Include the recipe, cure(s), and special instructions to be performed.

N/A

If material is to be tested in the "as received" condition, without further processing required, indicate in full the past history, recipe, cure(s), post cure(s), nomenclature of components, etc.

AS RECEIVED

CVCN test specimen preparation and description

CUT INTO CHUNKS, PLACED IN BOATS

Bar position-CVCN Test Number	16 27433	17 27434	18 27435
Init mass, holder and specimen, gm	123244	152344	713306
Mass of holder, gm	034610	033872	033180
Init specimen mass @ 50 %RH, gm	088633	123432	129406
Mass after 50 %RH re-soak, gm	123123	156895	212626
Final mass, holder & specimen, gm	13031	151911	212536
Total mass loss, specimen gm	000218	000533	000850
Percent TML, specimen	26 %	43 %	47 %
Average value TML	000052	000039	000090
Total mass, water vapor regain, gm	06 %	01 %	05 %
Percent water vapor regain	06 %	01 %	05 %
Average value WVR @ 50 %RH	1.769769	1.270517	1.772144
Final mass, collector, gm	1.369712	1.370867	1.377062
Initial mass, collector, gm	000051	000052	000052
Collected mass-CVCN, gm	06 %	04 %	05 %
Percent CVCN	06 %	04 %	05 %
Average value CVCN	06 %	04 %	05 %

Remarks: CVCN (unweighable) on separator plate to _____ mm diameter. CVCN appearance as follows: _____ is not detectable on collector plates.
 thin: ☒ heavy: ☒ color: _____ transparent: _____ colored liquid: _____

☐ opaque; ☐ matte; ☒ interference fringes; ☐ foggy; ☐ distorts eye reflection; ☐ smooth; ☐ smoky; ☒ splitchy; ☐ partially opaque;
☐ clear liquid; ☐ liquid runs in excess; Deposit covers 70 % of collector disc.

Specimen appearance after test:

No visible change

Test started OCT 23 2000 Test completed: OCT 24 2000 Period 24 Hrs Pressure _____ Pascal
 Specimen Temp. 125 °C Collector Temp. 25 °C Analyst Neil A. Walter

304 Stainless Steel for Inserts (Bushings)

MILL TEST REPORT

TA CHEN INTERNATIONAL CORPORATION

www.tachen.com

This MTR contains 1 page (Page: 1)

MTR#: NARB2235 Customer#: IMSPHO PO#: Z28308 SO#: LD9314
Item#: R84L0100 Bundle#: NA5396007



North American Stainless
6870 Highway 42 East
Ghent, Kentucky 41045-9615
Telephone: (502) 347-6000
FAX: (502) 347-6001

Email: customerservice@northamericanstainless.com

NA5396007-08

NORTH AMERICAN STAINLESS INSPECTION CERTIFICATE

CUSTOMER
TA CHEN INTERNATIONAL CORPORATION

TOLERANCE
ASTM-A-484-00

PRODUCT
Round bar, annealed, pickled, cold drawn

2005 / 32140
PACKING LIST # 2005 / 22609
GRADE NAS-143 P.O.# : L12408
AISI (304L/304)
DATE 1/25/2005
NUMBER 1
Item Code:

ORDER NUMBER	MARKS / PROD ID	HEAT NUM	WEIGHT
IND9644	44025/BA43330	0619	1565
"	44026/BA43772	0619	2380
"	44027/BA43773	0619	1565
"	44028/BA43780	0619	1497
"	44029/BA43781	0619	1727

REQUIREMENTS									
AISI									
LENGTH 12.00 ft									
SIZE 1.00000 Inches									
MECHANICAL PROPERTIES									
HEAT NUM	F _u UTS	R _{p0.2} YS	R _{p1.0} YS	Z% RA	ELONG A ₅ L _{4d}	HARDNESS HB	RESILIENCE J	A% %L _d	
0619	108	86		66	42	223		5	
Required Values	75	30		50		140 223		000000	

CHEMICAL COMPOSITION %									
HEAT NUM	C	P	S	SI	Mn	CE	NI	MO	N
0619	.0210	.0280	.0264	.3850	1.4200	18.4720	8.7230	.2350	.0865
REQUIRED VALUES	.0300	.0450	.0300	1.0000	2.0000	20.0000	12.0000		.1000
									.2490
									.2010

OBSERVATIONS
UNS-330400/30403, ASTM A276/03, Q35-2637, ASTM A479/03, AMS 5647H, ASME SA479/04, AMS 5639H, EN 10204 3.1B
ASTM A193/03 Class 1 grade B (EXC PAR 6.3), ASTM A120/03 Class 1 grade B, ASTM A182/02 (CHEM ONLY)
ASTM SA193/04 Class 1 grade B, ASME SA193/04 Class 1 grade B (EXC PAR 6.3), ASME SA182/04 (CHEM ONLY)
FREE FROM MERCURY AND LOW NITROGEN ALLOY CONTAMINATION, NO WELD REPAIR, HEATED TO 1900F MIN AND QUENCHED.

STEELMAKING PROCESS
EAF+AD+CC
QUALITY INSPECTOR
Eric Hess
Quality Control Representative

SURFACE AND DIMENSION CONTROL
WITHOUT OBJECTIONS
INTERGRANULAR CORROSION
ASTM-A-262-01
PRACTICE "B"
SATISFACTORY



Aluminum/Brass/Copper/Stainless, Carbon & Alloy Steels

**CAPITOL
METALS**

An Industrial Metal Supply Company

5150 South 48th Street, Phoenix, Arizona 85040
602.454.1500 Fax 602.454.1540
1 800.654.9076

Other Locations:

Burbank CA (800) 371-440
Irvine CA (800) 350-676
San Diego CA (800) 636-355

MATERIAL CERTIFICATION

SOLD TO:

COMPOSITE MIRROR APPLICATION 4
1638 S RESEARCH LOOP STE 100
TUCSON, AZ 85710

SHIPPER:

069180

CUSTOMER P.O. #

JIM3905

DATE

03-09-05

OUR TRUCK

Page: 1

ITEM NUMBER	DESCRIPTION ALLOY TEMPER										SPECIFICATIONS	QUANTITY
61ES4000 04	ALUM EX SQ 6061-T6511 BLU ASTM-B-221 4 SQ X 12 FT											153 LI
ALLOY NBR	SI	FE	CU	MN	MG	CR	ZN	TI	EA	TOT		
6061	.40	.70	.15	.15	.80	.04	.25	.15	.05	.15		
	.80	MAX	.40	MAX	1.2	.35	MAX	MAX	MAX	MAX		
61ES2000 04	ALUM EX SQ 6061-T6511 BLU ASTM-B-221 2 SQ X 12 FT											19 LI
ALLOY NBR	SI	FE	CU	MN	MG	CR	ZN	TI	EA	TOT		
6061	.40	.70	.15	.15	.80	.04	.25	.15	.05	.15		
	.80	MAX	.40	MAX	1.2	.35	MAX	MAX	MAX	MAX		
04R1000 04	STNLS RD 304 YELLOW 1 RD X 12 FT R/L										QQS-763	3 LI
TYPE	C	MN	P	S	SI	CR	NI	CU	MO			
304	.08	2.00	.040	.030	1.00	18.0	8.00	.50	.50			
	MAX	MAX	MAX	MAX	MAX	20.0	10.5	MAX	MAX			

We hereby certify that the material covered by this report has been inspected in accordance with, and has been found to meet, the applicable requirements including a specifications forming a part of the description. Mill Test Reports are on file subject to examination.

By

TEST REPORT CLERK

NAAD
NATIONAL ASSOCIATION OF ALUMINUM DISTRIBUTORS

SHAPES

SHEET

BAR

TUBING

PLATE

PIPE

ALUMINUM

BRASS

COPPER

STEEL

LEAD

STAINLESS ST

**Huntsman
EPIBOND 1210- A/B
Adhesive**

Huntsman Advanced Materials Americas Inc.
Los Angeles
5121 San Fernando Road West
LOS ANGELES, CA 90039

Page 1 of
Printed on 10/18/2004

Standard Certification

Customer: E V ROBERTS
Purchase Order #: 37899

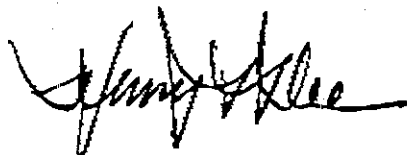
Order Entry Date: 09/16/2004
Order #: 209653
Delivery Note # 80293810

This is to certify that materials listed below, supplied against the purchase order as noted, were manufactured in accordance with our standard specifications and fully meet our quality control requirements.

<u>Material</u>	<u>Quantity</u>	<u>Batch Number</u>	<u>DOM</u>
138250100 PIBOND 1210-A/B (3X2 # A/1.35 # B)	4.00 EA	AK4JP9594K	
	Batch A:	AK4IA2368A	09/2004
	Batch B:	AK4DB2064A	04/2004

Shipping Date: 10/19/2004
Shelf Life from Date of Shipment by Huntsman: 12 Months

Approved by:



Henry B. Dee
Quality Control

NOTE: The preceding certification is provided for the convenience of the customer and does not relieve the purchaser of normal responsibility for inspection of material upon delivery or prior to actual use.

Printed:
November 11, 2004 11:59 am

Ship Date: Before November 11, 2004
Order Date: November 11, 2004
Date Date: November 15, 2004
Buyer Phone: 520-733-9302
Cust. P.O. #: Verbal
CSR: JMendoza
TechRep: 002 Clark Fisher
Customer #: 27822

Packing List: 144635-00

Carrier: FedEx Ground
Freight: PPD & Add
Freight Acct:
Terms: CC



Bill To: Composite Mirror Inc.
Attention: Accounts Payable
1638 South Research Loop # 100

Ship To: Composite Mirror Inc.
Attention: Receiving
1638 South Research Loop # 100

Tuscon AZ 85710-0000

Tuscon AZ 85710-0000

Notes:

Order	Shipped	B/O	Code	Products and Services	Container	Haz?
3	3	0	2904	EPIBOND 1210 A/B Kit (3/Case)	Quart Kit	No

Manufacturer Part Number: 138250100
Customer Part Number:



Specification Info:

Lot: (3) AK4IA2368A/AK4DB2064A

1	1	0	999988	E.V. Roberts Short Form Cert.	Each	N/A
---	---	---	--------	-------------------------------	------	-----

Manufacturer Part Number:
Customer Part Number:



Specification Info:

Notes:

1	1	0	999989	Material Safety Data Sheet	Each	N/A
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Manufacturer Part Number:
Customer Part Number:



Specification Info:

Notes:

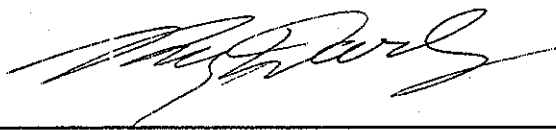
Customer Copy

E.V. Roberts now distributes the FREKOTE mold release and 3M Aerospace product lines. Call your local Technical Representative or (800) 374-3872 for Customer Service or Technical Support.

E.V. Roberts' Certificate of Compliance
18027 Bishop Avenue Carson, CA 90746-4019
(800) 374-3872

Specification:	General Sales
Certification Print Date:	Thursday, November 11, 2004
Customer Purchase Order:	Verbal
Order Date:	Thursday, November 11, 2004
Description:	Quart Kit EPIBOND 1210 A/B Kit (3/Case)
Customer Part Number:	
Manufactured By:	Huntsman Advanced Materials
Quantity: 3	Lot: AK4IA2368A/AK4DB2064A
Shelf Life:	12 Months@ 75 F From: MfgShip
Date of Manufacture:	Wednesday, September 1, 2004
Manufacturer Date of Shipment:	Tuesday, October 19, 2004
Expiration Date:	Wednesday, October 19, 2005
E.V. Roberts Order Number:	144635-00
E.V. Roberts Part Number:	2904
E.V. Roberts Shipment Date:	Thursday, November 11, 2004

Ray Darby, Quality and
Compliance Manager



This statement is to certify that the product shipped against this P.O. was manufactured in accordance with standard specifications and quality control procedures. This information is based on data received from the manufacturer, however no warranty is expressed or implied. The user should conduct their own testing to determine the suitability of this product for their particular application.

Huntsman Advanced Materials Americas Inc.
5121 San Fernando Road West
Los Angeles, CA 90039
818.247.6210

Customer Service Hotline: 800.367.8793
Customer Service Faxline: 517.351.6255
Technical Inquiries: 800.817.8260

HUNTSMAN

website: www.araldite.com
e-mail: adhesives_group@huntsman.com

Product Data

EPIBOND® 1210-A/B

EPOXY ADHESIVE

- General Purpose Adhesive
- Room Temperature Cure
- Variable Properties

DESCRIPTION

Epibond 1210-A/B epoxy adhesive is a two-part system with a semi-paste consistency. This adhesive product is ideal for spacecraft applications due to its low outgassing properties. Epibond 1210-B hardener can be used at varying ratios up to 100 parts by weight with Epibond 1210-A resin to achieve a more flexible bondline. Epibond 1210-A/B epoxy adhesive may be applied by brush, spatula, or automatic dispensing equipment. The epoxy adhesive is designed for bonding metal, wood, wood products, glass, ceramics, most plastics and many other materials.

TYPICAL PROPERTIES AS RECEIVED

<u>Property</u>	<u>1210-A Resin</u>	<u>1210-B Hardener</u>	<u>1210-A/B System</u>	<u>Test Method</u>
Color	Tan	Amber	Tan	Visual
Specific gravity	1.5	1.00	1.30	ASTM-D-792
Viscosity, cP @ 77°F (25°C)	250,000	30,000	Semi-Paste	ASTM-D-2393
Flash Point, COC, °F (°C)	490 (254)	275 (135)	—	ASTM-D-92
Work life, 100 gms at 77°F (25°C), minutes	—	—	50-75	ASTM-D-1338
Shelf life at 77°F (25°C), unopened, months	12	12	—	FTM-204
Solids, %	—	—	100	ASTM-D-1644

MIX RATIO

To 100 parts by weight of Epibond 1210-A resin, add 65 parts by weight of Epibond 1210-B hardener. Mix both components thoroughly for several minutes to insure complete and uniform mixing. Up to 100 parts by weight of Epibond 1210-B hardener may be used for more flexible bonds.

CURE SCHEDULE

48 hours at 75-80°F (23-26°C), or 2 hours at 150°F (66°C), required for full cure.

TYPICAL CURED PROPERTIES (Not for specification purposes)

<u>Test</u>	<u>Result</u>	<u>Test Method</u>
Maximum service temperature, °F (°C)	200 (93)	ASTM-D-648
Tensile lap shear, Al/Al, at 77°F (25°C), psi (MPa)	2,500 (17.2)	ASTM-D-1002
steel to steel at 77°F (25°C), psi (MPa)	2,500 (17.2)	—
steel to steel at 150°F (66°C), psi (MPa)	500 (3.4)	—
polyester to polyester at 77°F (25°C), psi (MPa)	1,800 (12.4)	—
Fluid Immersion 7 days at 75°F (23°C), psi (MPa)		ASTM-D-1002
JP-4	2,550 (17.5)	—
Skydrol	2,600 (17.9)	—
Distilled Water	2,700 (18.6)	—
Outgassing: TML, %	0.65	ASTM-E-595
CVCM, %	0.01	—
Hardness, Shore D	80	ASTM-D-2240

CAUTION:

Huntsman Advanced Materials Americas Inc. maintains up-to-date Material Safety Data Sheets (MSDS) on all of its products. These sheets contain pertinent information that you may need to protect your employees and customers against any known health or safety hazards associated with our products. Users should review the latest MSDS to determine possible health hazards and appropriate precautions to implement prior to using this material. Copies of the latest MSDS may be requested by calling our customer service group at 800-367-8793 or emailing your request to adhesives_group@huntsman.com.

FIRST AID:

Eyes and skin: Flush eyes with water for 15 minutes. Contact a physician if irritation persists. Wash skin thoroughly with soap and water. Remove and wash contaminated clothing before reuse.

Inhalation: Remove subject to fresh air.

Swallowing: Dilute by giving water to drink and contact a physician promptly. Never give anything to drink to an unconscious person.

KEEP OUT OF REACH OF CHILDREN

FOR PROFESSIONAL AND INDUSTRIAL USE ONLY

IMPORTANT LEGAL NOTICE:

Sales of a referenced product ("Product") are subject to the general terms and conditions of sale of Huntsman Advanced Materials Americas Inc. ("Huntsman").

WARRANTY: Huntsman warrants to the Buyer that the Product will conform to the published specifications for that Product at the time of manufacture, and that the Product will be free from defects in material and workmanship in normal use.

DISCLAIMER AND LIMITATION OF LIABILITY: EXCEPT AS SET FORTH ABOVE, SELLER MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Huntsman cannot control Buyer's application and use of the Product and accepts no responsibility therefore. No statement or recommendation contained in any Product literature may be construed as a representation about the suitability of a Product for the particular application of Buyer or user or as an inducement to infringe any relevant patent. Buyer is responsible to ensure that its intended use of the Product does not infringe any third-party's intellectual property rights. Huntsman neither assumes, nor authorizes any representative or other person to assume for it, any obligation or liability other than as is expressly set forth herein. UNDER NO CIRCUMSTANCES SHALL HUNTSMAN BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL, SPECIAL OR OTHER INDIRECT DAMAGES AS A RESULT OF A BREACH OF ANY WARRANTY OR THE FAILURE OF A PRODUCT OR ANY CLAIM THAT IS ESSENTIALLY BASED UPON SUCH BREACH OR FAILURE. Any claim by Buyer, whether arising in contract, tort, negligence, breach of warranty, strict liability, or otherwise, related to a Product shall be limited to, and the sole liability of Huntsman and the sole remedy of Buyer for any claims shall be for, the purchase price of the Product in respect of which such claim is made. The foregoing DISCLAIMER AND LIMITATION OF LIABILITY supersedes Buyer's documents.

WARNING: Technical data and results are based upon tests under controlled laboratory conditions and must be confirmed by Buyer by testing for its intended conditions of use. The Product has not been tested for, and therefore is not recommended or suitable for, uses for which prolonged contact with mucous membranes, abraded skin, or blood is intended or likely, or for uses for which implantation within the human body is intended, and Huntsman assumes no liability for any such uses.

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Member of Royal Ten Cate

EXACTING MATERIALS FOR THE COMPOSITE INDUSTRY

EX-1515 Resin System

PRODUCT TYPE

225° F (107° C) – 250° F (121° C)
Cure Toughened Cyanate Ester

SERVICE TEMPERATURE

250° F (121° C) (Without Post Cure)
325° F (163° C) (With Post Cure)

TYPICAL APPLICATIONS

- High Dimensional Stability
Space Structures
- Optical Benches
- Reflectors
- Radomes and Antennae
- Spectra® Composites
- Aircraft Structures
- Low Observables
- Radar Transparent Structures

SHELF LIFE

7 days @ 25°C
6 months @ < 0°C

PRODUCT DESCRIPTION

The EX-1515 Cyanate Ester resin system is very unique among its peers in that it is able to achieve an extremely high level of conversion after a 250° F (121° C) cure. This level of conversion renders optimal mechanical properties, high radiation resistance, and low moisture absorption/low outgassing while retaining unparalleled toughness, a low, 244° F (118° C), stress free temperature and long out time. The resin system excels in its ability to resist microcracking, even when subjected to vicious thermal cycling and high levels of radiation exposure.

EX-1515 also displays low dielectric/low loss values similar to other Cyanate Esters which justifies its use in radome and antenna applications as well. Finally, EX-1515 can be post cured, free standing, to increase its thermal performance for temperature critical structures. Accept no imitations; ask for EX-1515!

NEAT RESIN PHYSICAL PROPERTIES

Moisture Absorption	0.04% (P75 Laminate Saturation @ 80°F (27°C), and 85% Relative Humidity)
Outgassing	TML: 0.179% VCM: 0.007%
Density	1.17 gm/cc
Tg	274° F (134° C) cured @250° F (121° C) 360° F (182° C) post cured @350° F (177° C)
CTE	34 ppm/° F (61 ppm/° C)
Thermal Conductivity	0.169 W/m*K

NEAT RESIN ELECTRICAL PROPERTIES

Dielectric Constant	2.8 @10 GHz
Loss Tangent	0.004 @10 GHz

MICROCRACKING DATA

Laminate Type	XN-50A Pitch 75 Graphite/EX-1515
Layup Configuration	0/30/60/90/120/150 Symmetrical, 60% Fiber Volume
Test 1	Conditioned from -112° F (44° C) to +250° F (121° C) for 250 Cycles
Results	0 Microcracks per Inch
Test 2	Conditioned 25 Cycles in and out of Liquid Nitrogen, exposed to 1 x 10 ⁹ Rads of radiation, then Conditioned 50 Cycles in and out of Liquid Nitrogen
Results	0 Microcracks per Inch

Revised 1/03

18410 Butterfield Blvd. ■ Morgan Hill, CA 95037 ■ (408) 776-0700 ■ Fax (408) 776-0107 ■ E-mail: bryte@brytetechn.com

Bryte M46J/EX-1515
Carbon Fiber Composite Material



Certificate of Material Conformance

Customer

Certification Number: 18696

Shop Order Number: 33241

Date: 9/21/2004

Company: Composite Mirror Applications

Buyer: Bob Romeo

PO #: Verbal

Resin Spec: N/A

Fabric Spec: N/A

Product

Product: M46J, 70 gsm/EX-1515, 12

Description: Graphite Cyanate Ester Unitape, 70 gsm FAW, 12" width, 250°F cure.

Fiber Type: M46J Graphite

Resin Type: Cyanate Ester, EX-1515

Manufacturing Information

Run/Mix Lot Number: 092004-1T1

Date of Manufacture: 9/20/04

Measured: Resin Content Values: Roll #1: 37% 13.2

Roll #2: 38% 13.2

Specified Resin Content : 38±3%

Shelf Life

(from date

of shipment):

7 days @ 77°F

6 months @ 0° F

Quantity

in Spec: 26.4 lbs

LR#:

COMMENTS:

Certified by

Quality Assurance
Manager
Barry Meyers

Form Rev 4/1/04



Certificate of Material Conformance

Certification Number: 18887

Shop Order Number: 33451

Date: 11/17/2004

Customer

Company: Composite Mirror Applications

Buyer: Bob Romeo

PO #: 10067

Resin Spec: N/A

Fabric Spec: N/A

Product

Product: M46J, 120 gsm/EX-1515, 12

Description: Graphite Cyanate Ester Unitape, 120 gsm FAW, 12" width, 250°F cure.

Fiber Type: M46J Graphite

Resin Type: Cyanate Ester, EX-1515

Manufacturing Information

Run/Mix Lot Number: 111604-2T1

Date of Manufacture: 11/16/2004

Measured: Resin Content Values: Roll #1: 30% 22.91

Roll #2: 29% 25.1

Roll #3: 30% 21.21

Specified Resin Content : 30±3%

Quantity
in Spec: 69.2 lbs

LR#: N/A

Shelf Life

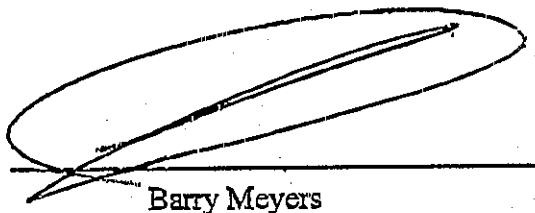
(from date

of shipment): 7 days @ 77°F

6 months @ 0° F

COMMENTS:

Certified by

Quality Assurance
Manager
Barry Meyers

Form Rev 4/1/04